Each of the three IRIDIUM feeder-link satellite antennas is independently steerable over the entire visible surface of the globe. The characteristics of the uplink antenna is as follows:

Receive: @ 29.2 GHz

- Polarization: RHCP
- Max. Isotropic Gain: 30.1 DBi
- Noise Temperature: 1295°K
- 3 dB Beamwidth: 5°

The IRIDIUM feeder link gateway Earth stations, which may, within sharing restrictions, be located anywhere in the world, will have the following typical characteristics:

Transmit: @ 29.2 GHz

- Antenna Diameter: 3 M
- Maximum Isotropic Gain: 56.3 dB
- Off-Axis Gain: 29-25 logθ
- Beamwidth: 0.24°
- Polarization: RHCP
- Total Peak Power: $\pm$ 12 dBW
- Max. Power Density: -52.9 dBW/Hz

The IRIDIUM satellites demodulate the service links and direct the signal to the appropriate link; service, intersatellite, or feeder. This technique minimizes the feeder-link loading. However, system operational traffic will increase the use of the Feeder-links.

3.0 Sharing/Coordinating with LMDS

The technical rules proposed by the Commission for the LMSS are intended to be "less restrictive" to promote flexibility for the licensee to meet market demands of those considered in the designated areas. As a consequence of this lack of specificity, it has been necessary to carry out a sharing/coordination analysis on the basis of the technical characteristics in the proposed "Suite 12" implementation of this service as described in its David Sarnoff Research Report.

Suite 12, has proposed a cellular like system with groups of millimeter stations collecting broadcasted FM video with small antennas mounted on user subscriber homes and businesses. The signals are broadcast from Hubs spaced about 12 miles apart in a grid. They operate in the 27.5 to 29.5 GHz frequency region with two separate bands of 1000 MHz for A and B system. Each 1000 MHz band is divided into 50 channels of 20 MHz each and the 20 MHz channels are further divided in 18 MHz of broadcast video and 2 MHz available for two-way conversation/data between each user and the hub. The baseline design assumes that the two-way channels would consist of 30 KHz FM channels similar to analog cellular. Frequency reuse between cells is achieved by alternating the hub's vertical and horizonal polarization for the video broadcast channels. The forward narrow band link to each subscriber is cross polarized with the video transmissions.

IRIDIUM plans to locate Gateway feeder link stations in the CONUS. These must be located such that they can economically connect to a local PSTN. There will be two groups of stations in the US and each group will consist of up to three Ka-Band transmitters which will be transmitting in the 29.1 to 29.3 GHz band with narrow beam circularly polarized antennas. The stations will track and be tracked by satellites from a minimum of 9° above horizon through the orbital path on each pass. More than one satellite will be tracked by the group at a time.

Two interference issues are examined to determine the possibility of cosharing of frequencies between IRIDIUM LEO feeder link and LMDS:

A) Interference from LMDS to MSS (LEO) satellite receivers

The IRIDIUM LEO has a receiver noise floor of -197 dBW/Hz on the feeder uplink. The Suite 12 hub antennas have low gain (10 dB) in the vertical plane suggesting a half power beamwidth of about 60 deg or 30 deg above the horizontal plane. Therefore, the maximum probability for interference from a collection of LMDS stations is when the satellite is moderately low on the horizon and a feeder Gateway station is located near the metropolitan area containing the LMDS hub stations. In this scenario, the hubs omni antennas couple tightly with the satellite uplink beam with an average gain of at least 7 dB. With the hubs planned for 12 mile grids then each hub would cover 113 square miles of territory. An IRIDIUM spot beam would cover about 2800 square miles and therefore be subjected to uplink interference power from 25 hubs at a time whenever a Gateway station is located in the same metropolitan area.

TABLE 1 UPLINK INTERFERENCE POWER INTO IRIDIUM SATELLITE

Hub Xmtr Power/channel	-5	dBW
Min Antenna Gain	7	dB
EIRP	2	dBW
Power Bandwidth (18 MHz)	-72.5	dB/Hz
Transmitted Spectral Density/Hub	-70.5	dBW/Hz
Factor for 25 interfering hubs	14	dB
Composite uplink power	-66.5	dBW/Hz
Average path loss	189	dB
Average Satellite Ant Gain	28	dB
Total Uplink Interference Power Into Satellite	-213	dBW/Hz
Satellite Noise Floor	-197.5	dBW/Hz
Percent added noise to receiver	3%	

As can be seen from the Table 1, the Suite 12 network of hub stations, would add a measurable amount of interference noise into a LEO satellite cosharing this frequency band even using nominal link parameters.

B) Interference from MSS(LEO) feeder earth stations to LMDS

Low sidelobe 3 meter dishes are employed for each Gateway station with power programming of the uplink to mitigate possibility of outages due to high density rain cells between a station and its LEO satellite. Typically the antennas would be mounted on a low building within a radome placing them around 50 above the ground close to the elevation of 70 feet planned for the LMDS hub stations. Under these circumstances it is necessary to examine Line of Sight (LOS) radio paths to determine the degree of interference injected into Suite 12 receive terminals using Mode 1 troposphere propagation distances.

Table 2 examines the LOS interference injected into a Suite 12 two-way link in Los Angeles. The forward and reverse link budgets are listed in the first two columns. As can be seen, for each climatic area, there is enough transmit power such that a clear air margin is established so that with average rainfall, there is greater than 99% probability they will maintain a minimum C/N of 13 dB for a path link of 4.5 miles. The links are balanced each way for the same margin. At the cells fringe area (9.0 miles) they employ 15 in. antennas to maintain same link margins.

When a Gateway station transmits, it could straddle one or more of the 30 KHz channels with the probability of interference highest into the hub's return link as the hubs are omni in the azimuthal plane. This interference will vary as it tracks the satellite with the maximum being when the station antenna is at its lowest elevation angle of 9° pointed on a radial to the hub and diminishing as it scans away from the Hub. Slew rates will be on the order of 10 seconds per degree at different radials for each satellite pass making for potentially long interference vents.

In columns 3 and 4 of Table 2, the average interference power from a Gateway into a Hub or subscriber receiver is calculated for the two cases of minimum uplink power in clear air and maximum through a rain cell. The distance was set to 20 miles which is about the maximum LOS distance between two stations elevated 70 feet above the round. Even with this much separation, the Hub receiver's C/N would be degraded 11.8 dB eliminating any rain margin when the Gateway is transmitting maximum power. If the

Gateway was at minimum power the link would be only slightly degraded.

This indicates that the Suite 12 and IRIDIUM gateway stations could not possibly coshare frequencies where LOS conditions prevail between the stations and the cellular network. Tropo or Mode (1) propagation works poorly at these frequencies so physical terrain isolation is a possibility but difficult to estimate. Site shielding of Gateway terminals would be impractical because of the low elevation coverage and requirement to scan 360. Thus to share, it would be necessary to have greater than LOS separation.

In Table 3 the possibility of interference into the users video receiver was evaluated. The Gateway must intercept the narrow user beam to affect the received C/N. This link is more susceptible because of its larger noise bandwidth and higher gain antenna. However, it is less likely to encounter a beam to beam coupling due to the narrowness of both beams. When such an encounter occurs there could be a complete outage of the users video channel for up to 10 seconds.

Table 2 Interference Into Suite 12 LMDS Two Way Link

Two-way Links for Los Angeles — 7.5 in dish

	Hub-User	User-Hub	Gateway Uplink into Cell Hub	
	Forward	Reverse	Clear	Rain
Freq	28.0	28.0	29.4	29.4
Xmtr Pwr (dBW/3 MHz)			-11.8	13.0
Xmtr Pwr (dBm/30 kHz)	-2.0	-2.0	-1.8	23.0
Ant feed Loss (dB)	1.0	1.0	1.0	1.0
Xmtr Ant Gain (dBi)	10.0	32.0	5.1	5.1
EIRP (dBm)	9.0	31.0	4.3	29.1
Path Length (miles)	4.5	4.5	20.0	20.0
Space loss @ 28 gHz (db)	138.6	138.6	152.0	152.0
Recvr Ant Gain (dBi)	32.0	10.0	10.0	10.0
Recved Carrier Power (dbm)	-97.6	-97.6	-137.6	-112.8
k (dBm/K/Hz)	-198.6	-198.6	-198.6	-198.6
Bandwidth: 30 khz (dB-Hz)	44.8	44.8	44.8	44.8
Receiver Temp (dB-K)	29.5	29.5	29.5	29.5
Rec eiver Noise Pwr (dBm)	-124.3	-124.3	-124.3	-124.3
			-124.1	-112.5
C/N (dB)	26.7	26.7	26.5	14.9
Min C/N Reqd	13.0	13.0	13.0	13.0
Rain Margin (dB)	13.7	13.7	13.5	1.9

Table 3 Interference Into Suite 12 LMDS video Link

Video Links for Los Angeles — 7.5 in dish

	Hub-User	Gateway Uplink into User Terminal		
		Clear	Rain	
Freq	28.0	29.4	29.4	
Xmtr Pwr/Channel (dBW/3 MHz)	-11.8	-11.8	13.0	
Ant feed Loss (dB)	1.0	-1.0	-1.0	
Xmtr Ant Gain (dBi)	10.0	5.1	5.1	gain 9°
EIRP (dBW)	-0.8	-7.7	17.1	
Path Length (miles)	4.5	20.0	20.0	
Space loss @ 28 gHz (db)	138.6	152.0	152.0	
Recvr Ant Gain (dBi)	32.0	32.0	32.0	
Recved Power (dbW)	-107.4	-127.6	-102.8	
k (dBW/K/Hz)	-228.6	-228.6	-228.6	
Bandwidth: 18 mz (dB-Hz)	72.6	72.6	72.6	
Receiver Temp (dB-K)	29.5	29.5	29.5	6 dB NF
Receiver Noise Pwr (dBW)	-126.5	-126.5	-126.5	
IM+Noise (dBW)	-125.9	-123.7	-102.8	N+I
C/N (dB)	18.5	16.3	5.2	
Min C/N Reqd	13.0	13.0	13.0	
Rain Margin (dB)	5.5	3.3	-7.8	